

MICREX-SX *SERIES* **SPH**

USER'S MANUAL

MODBUS Ethernet (TCP/IP) Communication FB

Introduction

Thank you very much for purchasing Fuji Programmable Controller.

This user's manual describes the specifications and handling of standard expansion FB used for MODBUS Ethernet data communication between the MICREX-SX series Ethernet interface module (NP1L-ET1) or a CPU with built-in SPH2000/3000 series Ethernet and external devices.

Please read this user's manual carefully for correct use of the product. Please also read the related manuals listed in the table below.

Name	Manual number	Description
MICREX-SX Series SPH User's Manual Command Edition	FEH200	Describes the memory, language, system definitions, and other contents of the MICREX-SX series.
MICREX-SX Series SPH User's Manual Hardware Edition	FEH201	Describes the system configuration, hardware specifications of each module, and handling of the MICREX-SX series.
MICREX-SX Series SPH User's Manual Ethernet Interface Module	FEH259	Describes the specifications and handling of the Ethernet communication modules.
MICREX-SX Series SPH User's Manual SPH2000/3000 Ethernet Communication Edition	FEH193	Describes the specifications and handling of Ethernet communication for CPU modules with built-in Ethernet.
MICREX-SX Series User's Manual D300winV3 < Reference Edition >	FEH257	Describes D300winV3 menu and icons as well as all operation methods.

※In addition to the above listed manuals, there are many other MICREX-SX related manuals as well as technical information available at our company Web site, <http://www.fujielectric.co.jp>

【Note】

- (1) Reproducing or copying part or all of the content of this manual without permission is prohibited.
- (2) Please note that the contents of this manual, including specifications, are subject to change for improvement purposes without prior notice.
- (3) We have taken every possible measure to prepare this manual. However, if you have questions or notice errors, kindly contact us at the sales office listed at the end of the manual. When contacting us, please provide the manual number listed on the front cover.

Safety Precautions

Before using this product, please read the “Safety Precautions” carefully for proper use.
The levels of safety precautions are classified into “Warning” and “Caution,” as described below:



: Improper handling may result in death or serious injury.



: Improper handling may result in medium to minor injury or physical damage.

Note that items listed under “ Caution ” may result in serious consequences in some situations.

Be sure to follow these precautions, as each of them is important.

 Warning

- Do not touch terminals or other live parts while the power is on. There is a risk of electric shock.
- Be sure to turn the power off when conducting installation, removal, wiring, and maintenance/inspection work. There is a risk of electric shock, malfunction, or failure if such work is performed while the power is on.
- Set up emergency stop circuits and interlock circuits outside the PLC. There is a risk of mechanical damage or accident as a result of PLC failure.
- Do not connect or charge reversely (+/-), disassemble, deform by pressure, throw into fire, or short-circuit the batteries. There is a risk of explosion or fire.
- If you notice battery deformation, fluid leakages, or any other abnormalities, do not use them. There is a risk of explosion or fire.

Safety Precautions



Caution

- Do not use a damaged or deformed product when it has been removed from the package. Doing so may result in fire, malfunction, or failure.
- Do not shock the product by dropping or overturning it. Doing so may result in product damage or failure.
- Install the product in accordance with the operating instructions and the manual. Improper installation may result in falling of the product, malfunction, or failure.
- Use the product at the rated voltage and current specified in the operating instructions and the manual. Use outside the specification may result in fire, malfunction, or failure.
- Use (store) the product under the environment specified in the operating instructions and the manual. Use (storage) under environments of high temperature, high humidity, condensation, dust, corrosive gas, oil, organic solvents, or significant vibration/impact may result in electric shock, fire, malfunction, or failure.
- Select a cable size suitable to the voltage applied or flowing current, and tighten cables with the specified torque. Improper wiring or tightening may result in fire, falling of the product, malfunction, or failure.
- Construct the equipment so that dirt, wire scrap, iron powder, or other foreign matter will not enter its interior. It may cause fire, accident, malfunction, or failure.
- After wiring is completed, be sure to remove the dust cover sheet from the module/unit prior to operation. Operation with the dust cover sheet on may result in fire, accident, malfunction, or failure.
- Be sure to ground the earth terminal. Failure to do so may result in electric shock or malfunction.
- Periodically check the terminal screws and the set screws for secure tightness. Use of the product with loose screws may result in fire or malfunction.
- Be sure to put the enclosed connector covers on unused connectors. Not doing so may result in malfunction or failure.
- Be sure to put the terminal covers over the terminal blocks. Failure to do so may result in electric shock or fire.
- When performing program changes, forced output, start-up, stop, etc. during operation, carefully check safety first. An operational error may cause the machine to move, resulting in mechanical damage or accidents.
- Plug in the loader connector in the proper direction. Failure to do so may result in malfunction.
- When touching the PLC, touch the grounded metal, etc. first to discharge any static electricity buildup from a human body, etc. Excessive static electricity may result in malfunction or failure.
- Perform wiring exactly according to the operating instructions and the manual. Improper wiring may result in fire, accident, or failure.
- When unplugging the cable from the outlet, do not pull the cord. The cable may break, causing fire or failure.
- Do not perform system changes (connecting/disconnecting I/O modules) while the power is on. Performing system changes while the power is on may result in malfunction or failure.
- Never attempt to repair this product by yourself. Please contact us for repair. In addition, make sure to attach connectors properly when replacing batteries. Improper connection may result in fire, accident, or failure.
- Do not alter or disassemble the product. Doing so may result in failure.
- When disposing of this product, treat it as industrial waste.
- The product described in this manual is not designed or manufactured with the intention to be used in life-critical equipment or systems.
- When considering using the product described in this manual for a special purpose, such as nuclear control, aerospace, medical use, traffic device, passenger mobile, and related systems, please contact our sales office.
- When applying the product described in this manual to facilities where the product failure could potentially threaten life or cause serious damage, be sure to install a safety device.
- For external power supply (DC24V, for example) to be connected to DC I/O, use a power source that is well insulated from the AC power source. (Use of EN60950-compliant power supply is recommended.) Doing otherwise may result in accident or failure.

Revision history

※The manual number is printed in the lower right-hand corner of the front cover of this manual.

Printed in	※Manual number	Revision detail
April 2011	FH321	Initial version printed.

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Chapter 1 Outline

1 – 1 Type of MODBUS Ethernet FB

MODBUS Ethernet FB is a function block to establish MODBUS Ethernet (TCP/IP) communication using the Ethernet communication functions of the CPU module with built-in SX series Ethernet (SPH2000/3000 series product with E at the end) or the Ethernet interface module (NP1L-ET1).

There are two types of FB, as shown below:

FB Name	Usage	Loader used
_C_emodm	For MODBUS Ethernet master station	SX-Programmer Expert (D300win)
_C_emods	For MODBUS Ethernet slave station	V3.5.3 * or later

Note) The standard loader and D300winV2 cannot be used.

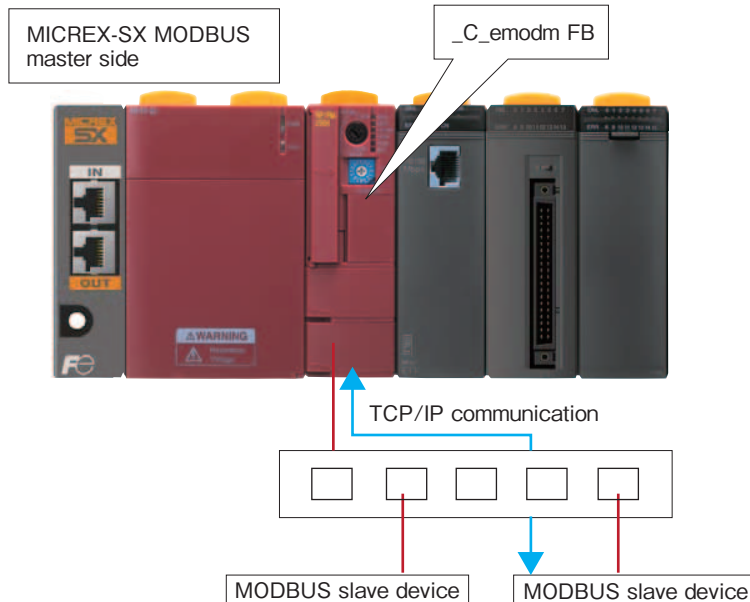
※The above FBs are included in the D300win product CD. They can also be downloaded from the technical information page on our Web site.

Chapter 1 Outline

1-2 Connection configuration

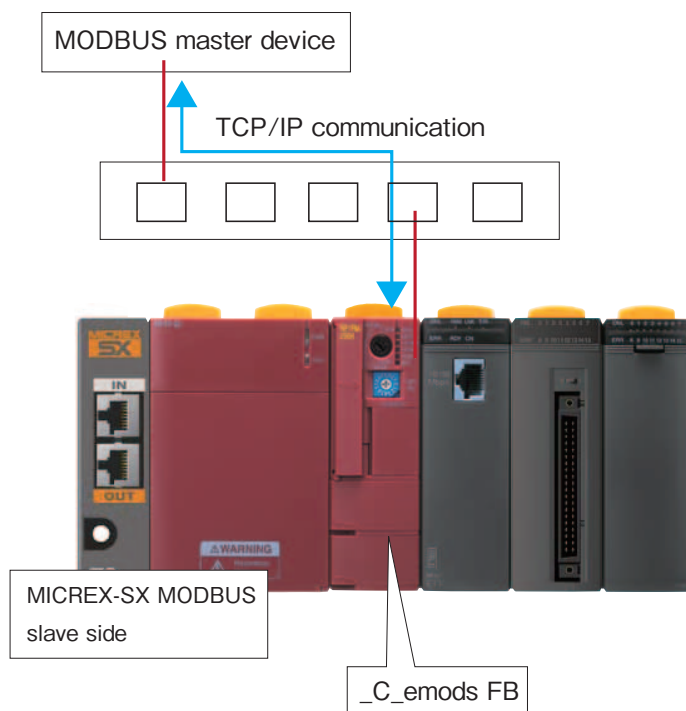
1-2-1 SX series as master station

MICREX-SX system, as the master station, transmits and receives data to/from slave devices. In this case, the MODBUS Ethernet FB uses master communication FB (`_C_emodm`).



(2) SX series as slave station

MICREX-SX system, as a MODBUS slave, transmits and receives data to/from the master device. In this case, the MODBUS Ethernet FB uses slave communication FB (`_C_emods`).



Chapter 2 Specifications

2 – 1 Transmission specifications

2 – 1 – 1 MODBUS Ethernet (TCP/IP) specifications

Item	SPH300 series	SPH2000/3000 series
Transmission procedure	MODBUS/TCP	
Data	Binary (252 bytes/frame)	
IP address	Set by system-defined module property. Factory default setting: NP1L-ET1 :192.168.0.1 CPU with built-in Ethernet :192.168.0.1	
Port number	MODBUS master (client): 1 – 65535 MODBUS slave (server): 502	
Interface	10BASE-T/100BASE-TX	
Compatible Ethernet	NP1L-ET1	CPU' s built-in Ethernet or NP1L-ET1
Number of nodes available for simultaneous communication	Maximum 16 stations (NP1L-ET1 specification)	When using NP1L-ET1: Maximum 16 stations When using CPU with built-in Ethernet: Maximum 10 stations

2 – 2 MODBUS Ethernet master FB _C_emodm

2 – 2 – 1 _C_emodm specifications

_C_emodm is a FB for MICREX-SX, as the master, to perform data communication with MODBUS slave devices.

※For transmission parameters for MODBUS devices, refer to the manual of each device.

(1) Function codes

This FB supports the following function codes. For data format for each function code, refer to “(4) Message format.”

Function code	Function
01	01 Read coil (output).
02	02 Read input.
03	03 Read holding register.
04	04 Read input register.
05	05 Force ON/OFF (1 bit).
06	06 Write holding register (1 word).
0F	07 Force ON/OFF (multiple bits).
10	08 Write holding register (multiple words).

(2) FB memory size

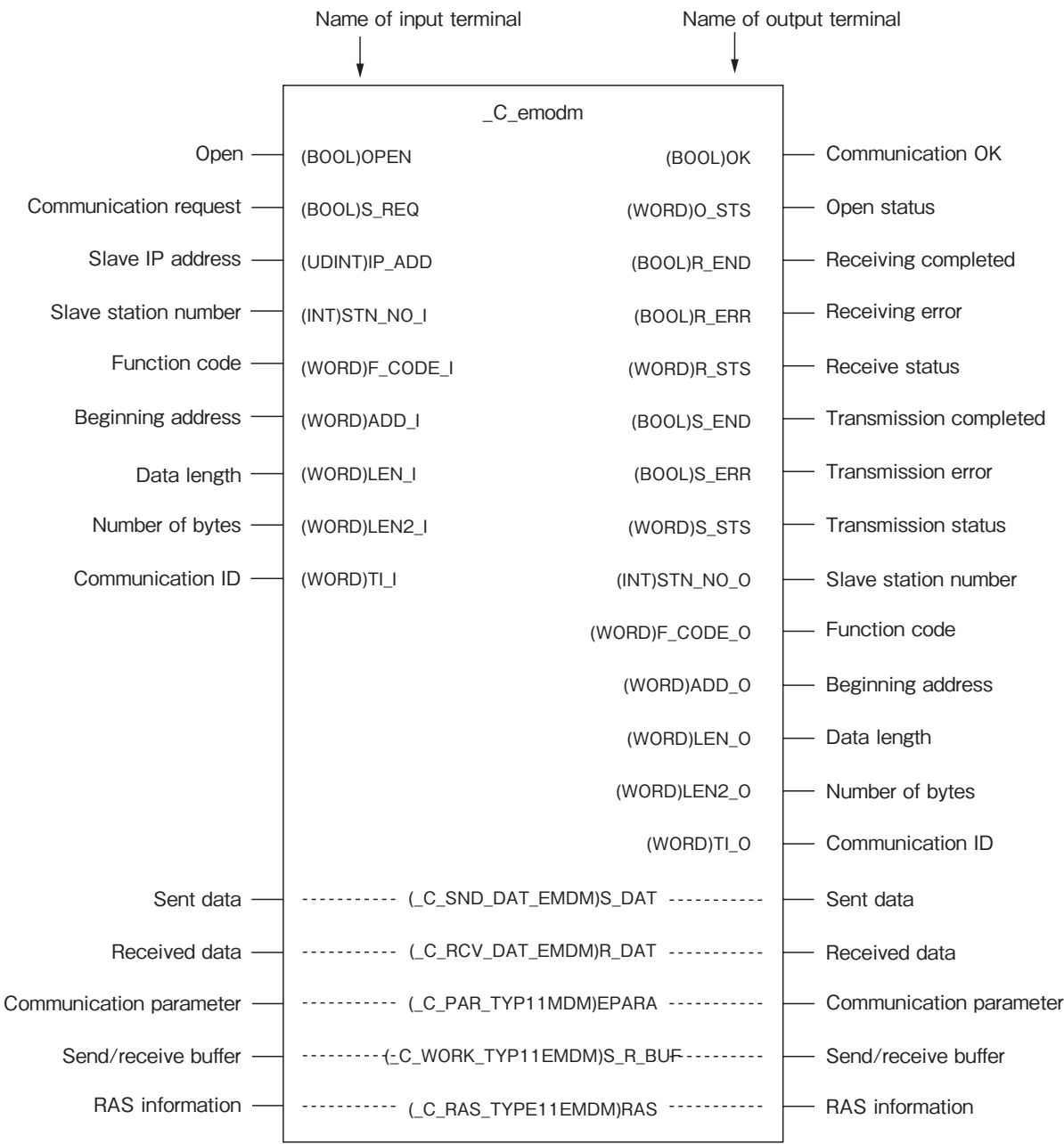
Program area = 1470 steps

Data memory size = Instance memory for user FB	:136 words
Standard memory	:570 words
Retain memory	:10 words
Instance memory for system FB	:58 words

Note1) The above memory size includes the sizes of MODBUS FB itself and sub-FB accessed by MODBUS FB.

Note 2) The above “standard memory” or “retain memory” size includes the memory required to transmit/receive data.

(3) FB form



(4) Description of each terminal

Name of terminal	Variable name	Data type	Input/output	Description
Open	OPEN	BOOL	IN	ON: Opens channel with MODBUS slave device. When communication becomes available, "communication OK" turns ON. OFF: Ends communication. "Communication OK" turns OFF.
Transmission request	S_REQ	BOOL	IN	Starts sending data. When transmission is completed, it must be turned OFF using application.
Slave IP address	IP_ADD	UDINT	IN	Starts sending data. When transmission is completed, it must be turned OFF using application.
Slave station number (Query)	SIN_NO_I	INT	IN	Not used for this FB. Set INT#0 for the terminal.
Function code (Query)	F_CODE_I	WORD	IN	Specify MODBUS function to be used. Set the code to low byte. Example) In the case of function (01h) - read coil, WORD#16#0010.
Beginning address (Query)	ADD_I	WORD	IN	Specify the beginning address of data to be read or written. Set data in the following format: 15 8 7 0 High Low
Data length (Query)	LEN_I	WORD	IN	Specify the size (number of bits or words) of data to be read or written. This may not be used depending on the function used. In that case, set "0000h." Set data in the following format: 15 8 7 0 High Low
Number of bytes (Query)	LEN2_I	WORD	IN	Specify the number of data bytes to be written when writing multiple bits (0F) or multiple words (10). In the case of other functions, set "WORD#16#0000." Set data in the following format: 15 8 7 0 High Low
Communication ID (Query)	TI_I	WORD	IN	Used to match response data from MODBUS slave devices. Generally, increment by +1 for each request in the range of 0 to 65535 (0 - FFFF). If it is not used, set "WORD#16#0000." If it is used, adjust it according to the specification of the slave device used.
Sent data	S_DAT	_C_SND _DAT_EMDM	IN_OUT	Stores sent data. In the case of data readout and diagnosis, set all data to 0.
Received data	R_DAT	_C_RCV_ DAT_EMDM	IN_OUT	Stores received data.
Communication parameter	PARA	_C_PAR _TYP11MDM	IN_OUT	Stores parameters for initialization. For details, refer to 2-2-1 (6).
Send/receive buffer	S_R_BUF	_C_WORK_ TYP11EMDM	IN_OUT	Memory internally used by this FB. Do not access this in applications.
RAS information	RAS	_C_work _TYPE11MD	IN_OUT	Stores operation status of this FB.
Communication OK	OK	BOOL	OUT	Turns ON when channel opening with MODBUS slave device is completed normally.
Open status	O_STS	WORD	OUT	2-digit hexadecimal code to indicate open result.
Receiving completed	R_END	BOOL	OUT	Turns ON when data receiving from MODBUS slave device is completed normally.
Receiving error	R_ERR	BOOL	OUT	Turns ON when an error occurs while receiving data from MODBUS slave device.
Receive status	R_STS	WORD	OUT	Code to indicate receiving result.
Transmission completed	S_END	BOOL	OUT	Turns ON when sending of data to MODBUS slave device is completed normally.
Transmission error	S_ERR	BOOL	OUT	Turns ON when sending of data to MODBUS slave device is abnormally ended.
Transmission status	S_STS	BOOL	OUT	Code to indicate transmission result.

Name of terminal	Variable name	Data type	Input/output	Description
Slave station number (Response)	STN_NO_O	INT	OUT	Outputs the number of the responding slave station.
Function code (Response)	F_CODE_O	WORD	OUT	In response to the request from this FB, values of "function code," "beginning address," "data length," and "number of bytes" in the response data from the slave device are output. They are output in the same formats as those set for input (Query).
Beginning address (Response)	ADD_O	WORD	OUT	
Data length (Response)	LEN_O	WORD	OUT	
Number of bytes (Response)	LEN2_O	WORD	OUT	
Communication ID (Response)	TI_O	WORD	OUT	

< Definition of array >

The array data in this FB are defined as follows:

TYPE

```

_C_PAR_TYP11EMDM :ARRAY[0..9] OF UINT; (*parameter area*)
_C_SND_TYP11EMDM :ARRAY[0..131] OF WORD; (*send buffer area*)
_C_RCV_TYP11EMDM :ARRAY[0..131] OF WORD; (*receive buffer area*)
_C_SND_DAT_EMDM :ARRAY[0..125] OF WORD; (*sent data area*)
_C_RCV_DAT_EMDM :ARRAY[0..125] OF WORD; (*received data area*)
_C_WORK_TYPE11EMDM :
  STRUCT
    SND_BUF : _C_SND_TYP11EMDM; (*send buffer*)
    RCV_BUF : _C_RCV_TYP11EMDM; (*receive buffer*)
  END_STRUCT;
_C_RAS_TYP11EMDM : ARRAY[0..9] OF INT; (*RAS area*)
END_TYPE

```

< Format of variable connected to sent data terminal S_DAT >

Arrange array variables to be connected to S_DAT, as follows:

< Assuming that the variable name is S_DAT >

```

VAR
  S_DAT : _C_SND_DAT_EMDM;
END_VAR

```

	High	Low
S_DAT[0]	Data2	Data1
S_DAT[1]	Data4	Data3
⋮	⋮	⋮
S_DAT[124]	Data250	Data249
S_DAT[125]	Reserve	Reserve

< Format of variable to be connected to received data terminal R_DAT >

Data to be connected to R_DAT are arranged as follows:

< Assuming that the variable name is R_DAT >

```

VAR
  R_DAT : _C_RCV_DAT_EMDM;
END_VAR

```

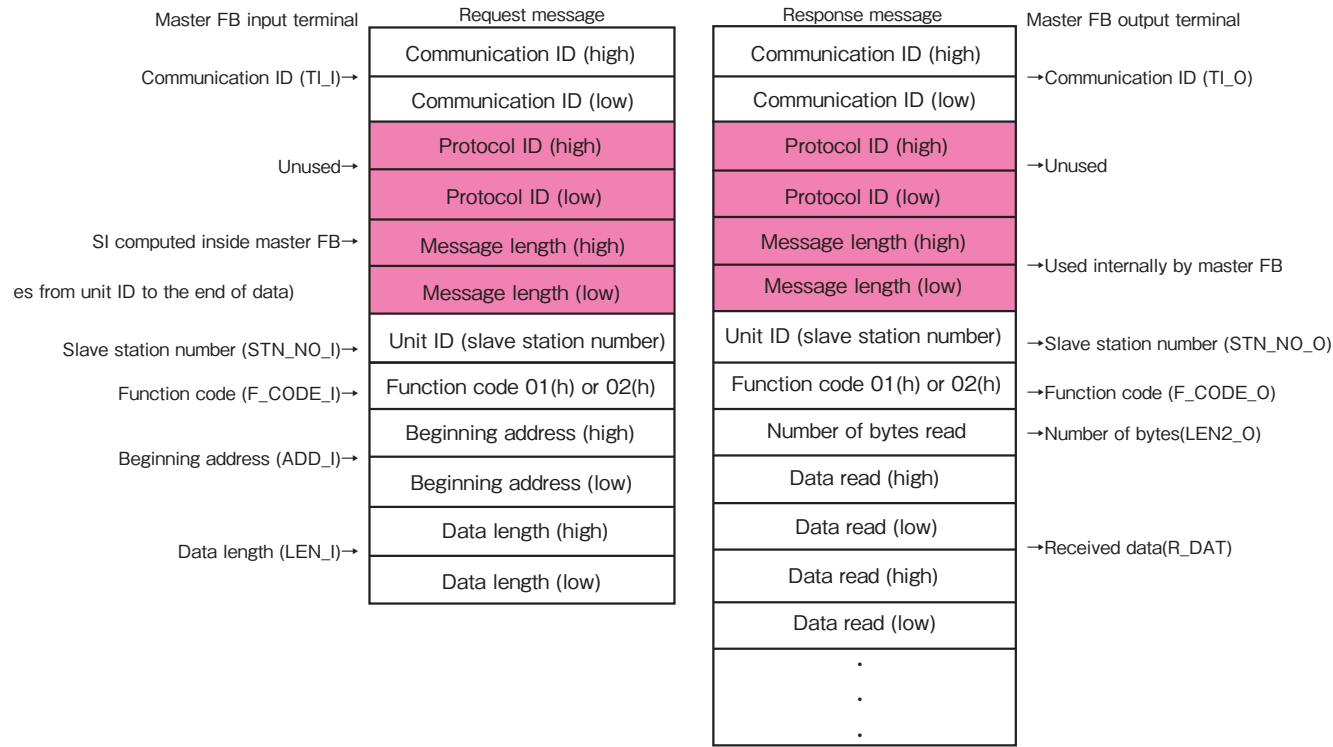
	High	Low
S_DAT[0]	Data2	Data1
S_DAT[1]	Data4	Data3
⋮	⋮	⋮
S_DAT[124]	Data250	Data249
S_DAT[125]	Reserve	Reserve

Note) Reserve is internally used by this FB. Do not attempt to access it.

(5) Message format by function code

① Read coil (code: 01(h)) / Read input bit (code: 02(h))

Read the coil/input bit status of the slave device. The formats of request and response messages are as follows:



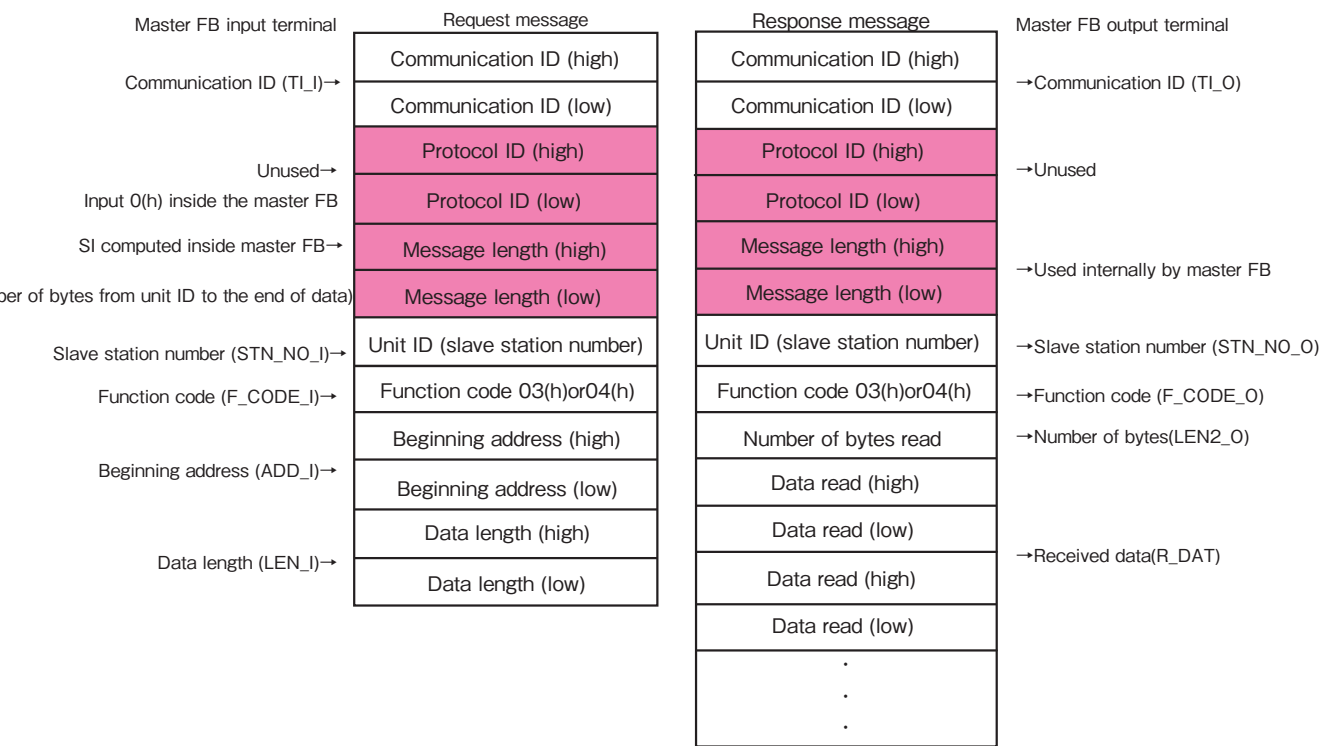
- ※ 1 For data length (LEN_I), specify the number of bit points read (1 to 2000 points).
- ※ 2 The number of bytes (LEN2_I) is not used in function 01/02. Set LEN2_I terminal to "WORD#16#0000." Similarly, set all data of variables connected to sent data (S_DAT) to 0.
- ※ 3 The number of bytes read is stored in the high byte of data length (LEN_O).
- ※ 4 Read data are received with high bytes and low bytes in reverse, as shown below:

Received data (R_DAT) This is an offset address using the specified beginning address as a reference.

+7	+6	+5	+4	+3	+2	+1	+0	+15	+14	+13	+12	+11	+10	+9	+8
+23	+22	+21	+20	+19	+18	+17	+16	+31	+30	+29	+28	+27	+26	+25	+24

② Read holding register (code: 03(h)) / Read input register (code: 04(h))

Read the input bit status of the slave device. The formats of request and response messages are as follows:

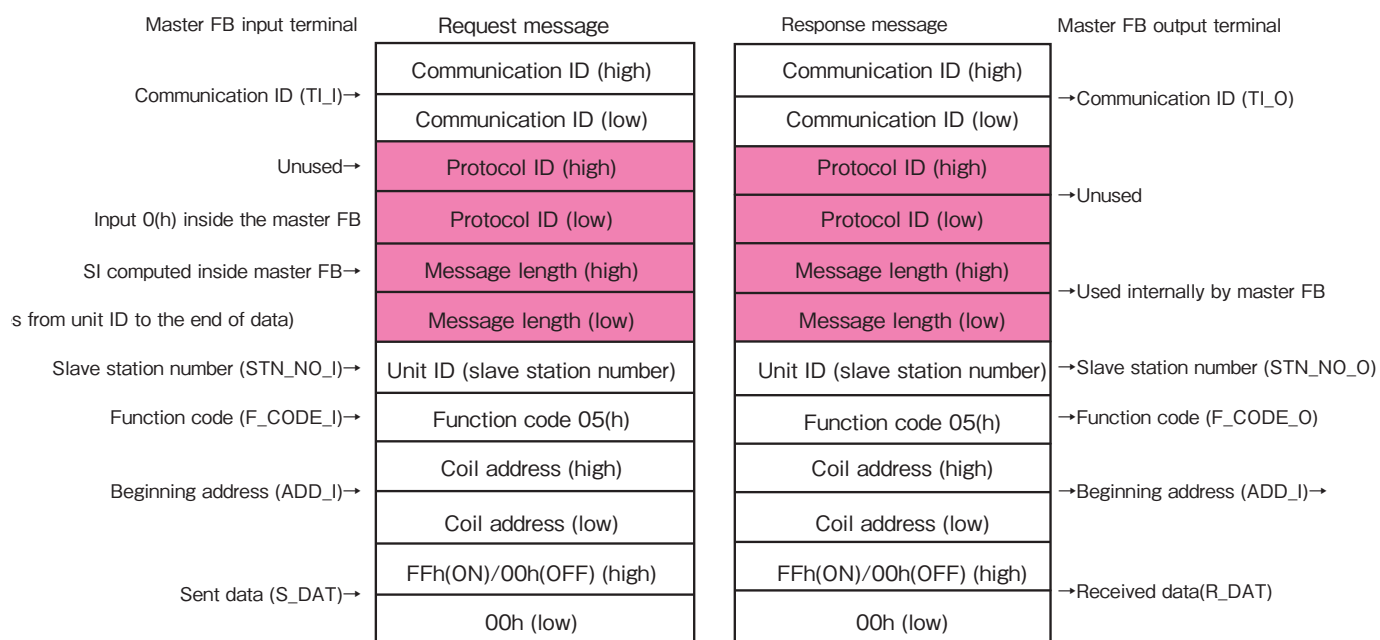


- ※ 1 For data length (LEN_I), specify the number of words in the read register (1 to 125 words).
- ※ 2 The number of bytes (LEN2_I) is not used in function 03/04. Set LEN2_I terminal to “WORD#16#0000.” Similarly, set all data of variables connected to sent data (S_DAT) to 0.
- ※ 3 The number of bytes read is stored in the high byte of data length (LEN_O).
- ※ 4 Read data is received in the order of high bytes and low bytes, as shown below. Therefore, data in word units can be accessed, as is, in word units.

Received data (R_DAT)→	High byte	Low byte
	High byte	Low byte
	High byte	Low byte
	:	:

③ Force ON/OFF (1 bit) (code: 05(h))

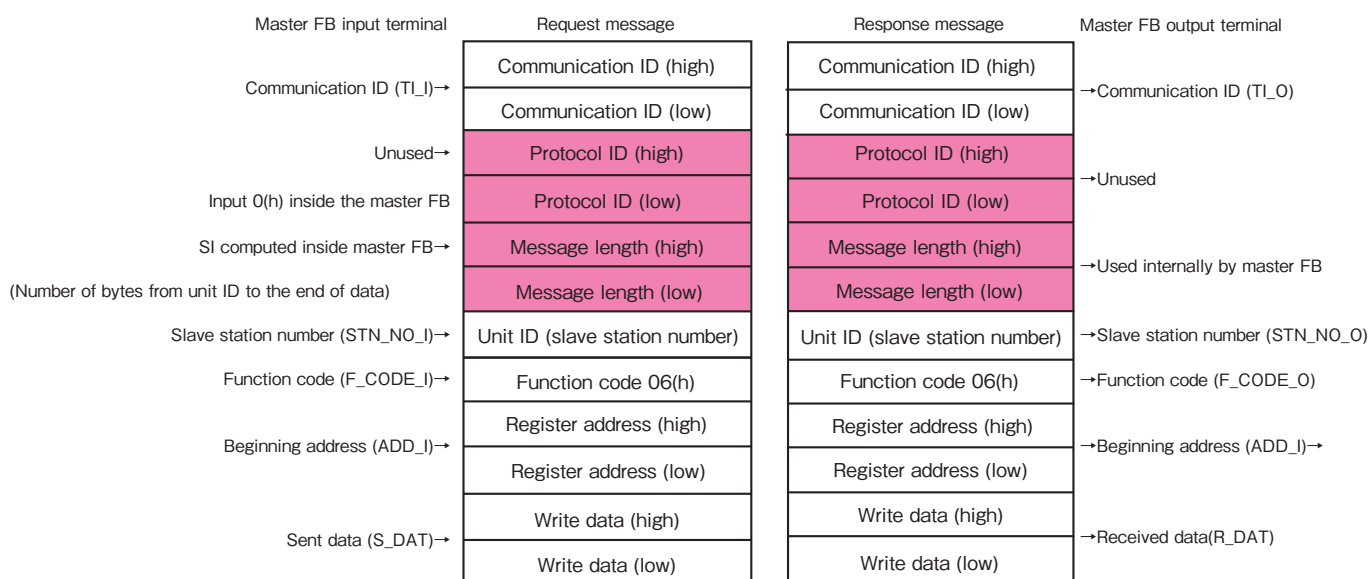
Force the bit (coil) specified by the slave station to be ON/OFF. The formats of request and response messages are as follows:



- ※ 1 Data length (LEN_I) and number of bytes (LEN2_I) are not used in function 05. Set each terminal to "WORD#16#0000."
- ※ 2 The force ON command sets the beginning word of sent data to WORD#16#FF00. The force OFF command sets it to WORD#16#0000.

④ Write holding register (1 word) (code: 06(h))

Write data in the register (1 word) specified by the slave device. The formats of request and response messages are as follows:

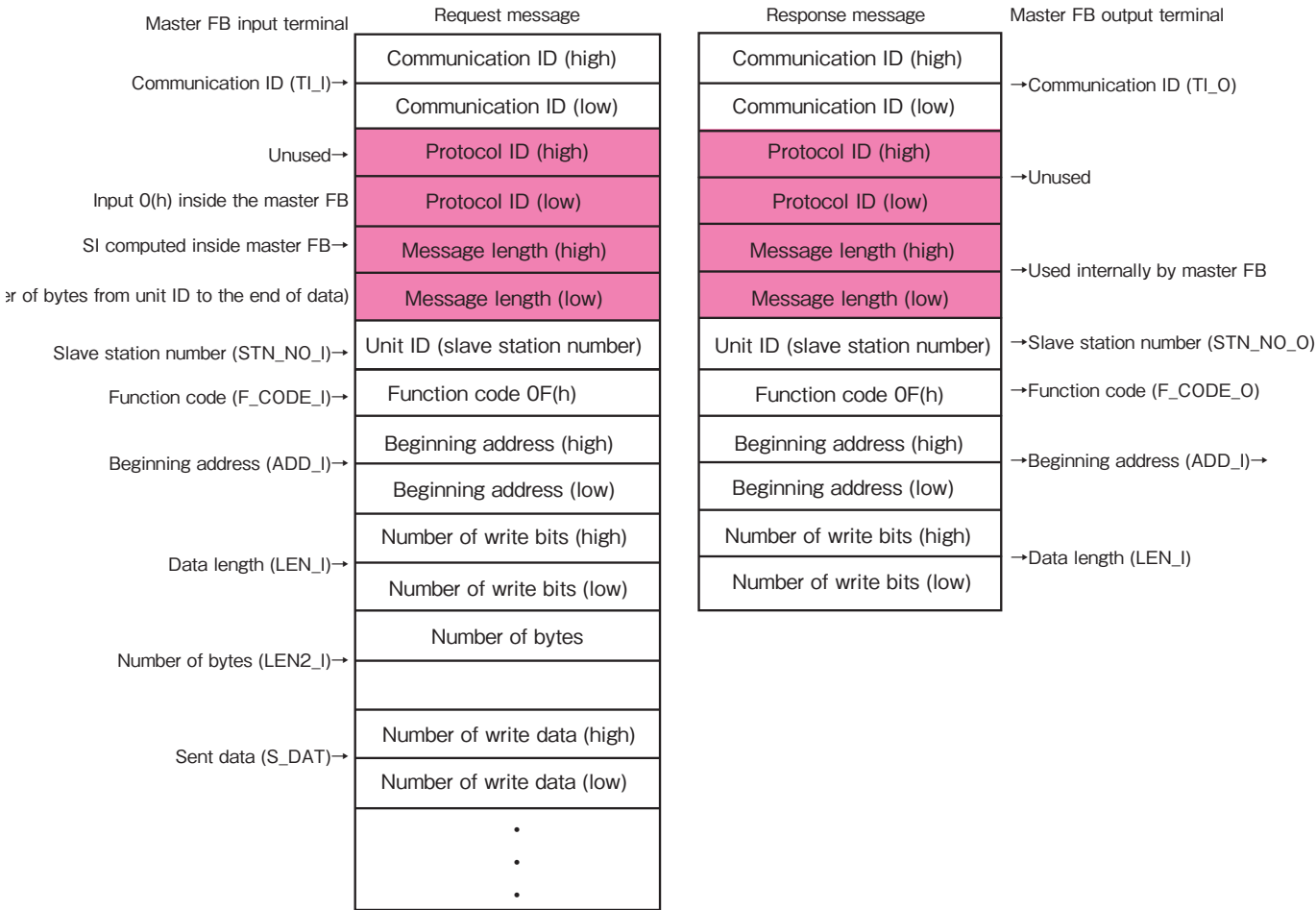


※ 1 Data length (LEN_I) and number of bytes (LEN2_I) are not used in function 06. Set each terminal to "WORD#16#0000."

※ 2 For sent data (S_DAT), set data to be written in the beginning word.

⑤ Force ON/OFF (multiple bits) (code: 0F(h))

Force the bit (coil) specified by the slave station to be ON/OFF. The formats of request and response messages are as follows:



- ※ 1 For data length (LEN_I), specify the number of bit points to be written (1 to 1968 points).
- ※ 2 For number of bytes (LEN2_I), specify the number of bytes (1 to 246 bytes) of edited sent data (S_DAT).
- ※ 3 The number of bit points to be written specified for data length (LEN_I) should match the number of bytes specified for LEN2_I.
Example) If the number of bit points to be written is 1 to 8 points, set 1 byte. If it is 9 to 16 points, set 2 bytes.
- ※ 4 Set write data with high bytes and low bytes in reverse, as follows:

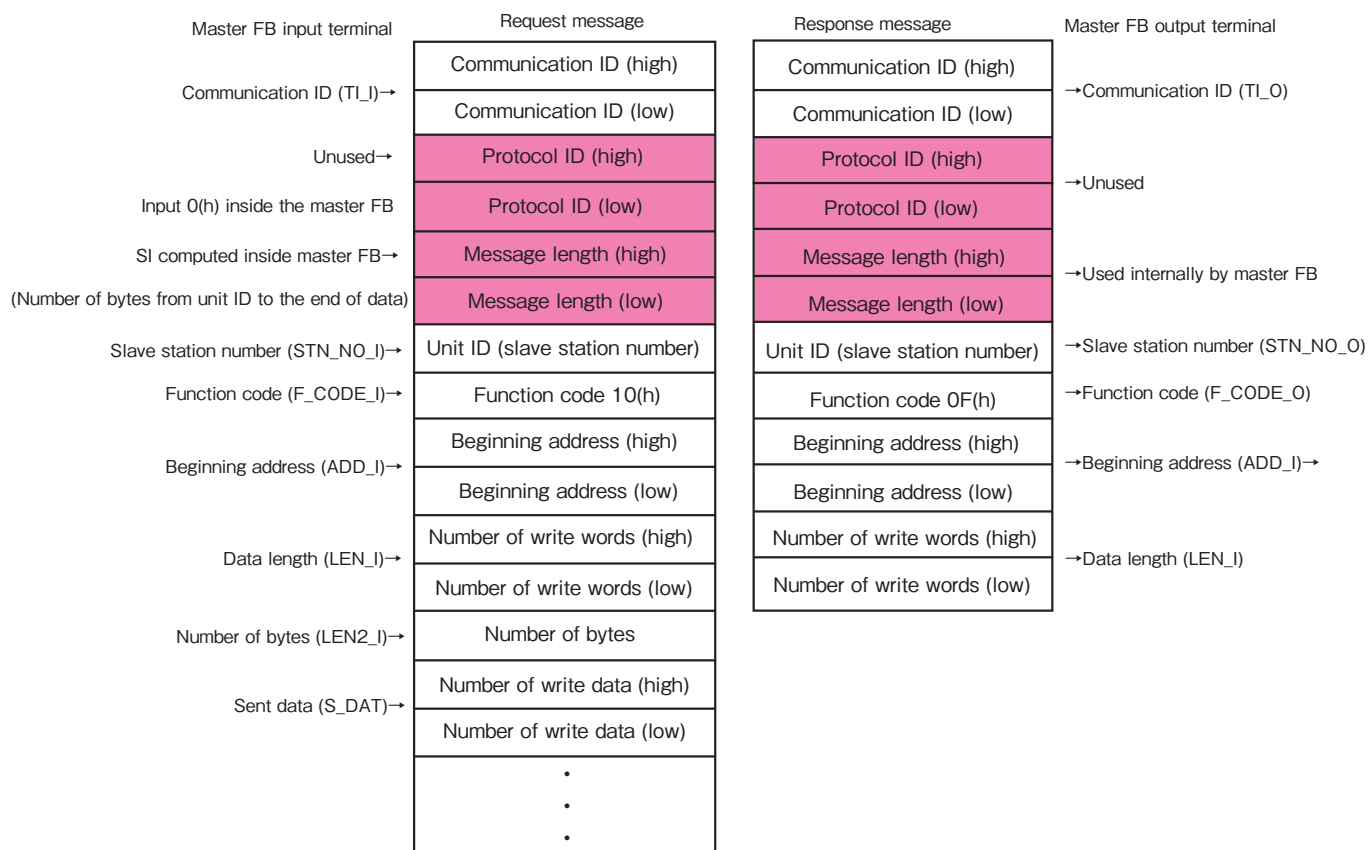
Sent data (S_DAT)

This is an offset address using the specified beginning address as a reference.

+7	+6	+5	+4	+3	+2	+1	+0	+15	+14	+13	+12	+11	+10	+9	+8
+23	+22	+21	+20	+19	+18	+17	+16	+31	+30	+29	+28	+27	+26	+25	+24

⑥ Write holding registers (multiple words) (code: 10(h))

Write data in the first register specified by the slave device and continuous registers that follow.
The formats of request and response messages are as follows:



- ※ 1 For data length (LEN_I), specify the number of words to be written (1 to 123 words).
- ※ 2 For number of bytes (LEN2_I), set the number of bytes (1 to 246 bytes) in sent data (S_DAT).
- ※ 3 The number of words to be written specified for data length (LEN_I) should match the number of bytes specified in LEN2_I.
- ※ 4 Set write data in the order of high bytes and low bytes, as shown below:

Sent data (S_DAT) →	High byte	Low byte
	High byte	Low byte
	High byte	Low byte
	:	:

⑦ Error response format

The format in response to an error is as follows. This applies to all functions.

Error response message	Master FB output terminal
Communication ID (high)	→Communication ID (TI_O)
Communication ID (low)	
Protocol ID (high)	→Unused
Protocol ID (low)	
Message length (high)	→Used internally by master FB
Message length (low)	
Unit ID (slave station number)	→Slave station number (STN_NO_O)
Function code 0F(h)	→Function code (F_CODE_O)
Error code	→Received data(R_DAT)

※ 1 Output to the function code (F_CODE_O) is a value of the function code requested from the master plus 80(h).

Example) If requested function code is 01(h), 81(h) is output to F_CODE_O.

< List of error codes >

01h: Error in function code

02h: Error in specified address

03h: Error in specified number of read/write data

(6) Communication parameters

There are two types of MODBUS Ethernet communication parameters: module parameters set in the system definition and parameters set in this FB.

① Module parameters

The parameters shown in the table below are set in the D300win system definition.

Item	Description	Initial value	Basic setting
IP address	IP address	192.168.0.1	Optional
	Subnet mask	255.255.255.0	Optional
Gateway	Default gateway	None	None
Detail setting	TCP send/receive timeout value: 0 to 300 (in units of 0.1 seconds)	300	300 Note 1)
	Maximum TCP end timer value: 0 to 600 (in units of 0.1 seconds)	0 (1 second)	0 (1 second)
	Response monitor timer value: 0 to 300 (in units of 0.1 seconds)	300 (30 seconds)	300 (30 seconds)
	Server FTP command monitor timer value (loader command monitor timer value): 0 to 3000 (in units of 0.1 seconds)	3000 (300 seconds)	3000 (300 seconds)
	Client FTP data connection monitor timer value (in units of 0.1 seconds) Note 3)	30	30
	Ethernet communication trace	No tracing	This setting is invalid.
	Transmission retry interval: 0 to 10 (in units of 1 second) Note 4)	0	This setting is invalid.
	Number of transmission retries: 0 to 30 times Note 4)	12	This setting is invalid.
	Closing when TCP transmission timeout occurs	No channel closing.	This setting is invalid.
	Closing when response receiving timeout occurs	No channel closing.	This setting is invalid.
	Own port reference number: 0 to 65280	256	Note 2)
	Communicating device's port reference number: 0 to 65280	256	0 Note 5)

Note 1) Set the same value as the "slave response monitor timer" specified for the communication parameter.

Note 2) For master-side actual port number, specify "1" if not specified by the communicating device or a port number (1 to 65535) not used in the connected network environment. Therefore, specify own port reference number, according to the actual port number to be set.

Note 3) This item is set for NP1L-ET1 only. The Ethernet parameters of CPU with built-in Ethernet do not include this item.

Note 4) This item is set for the Ethernet of CPU with built-in Ethernet only. NP1L-ET1 does not include this item.

Note 5) The slave-side actual port number is fixed at "502" inside the master FB (MODBUS Ethernet specifications).

Therefore, specify "0" for the communicating device port reference number.

② Communication parameter settings in FB

Items to be set in array variables (data type: Array of 10 _C_PAR_TYP11EMDM UINT types) are shown in the table below:

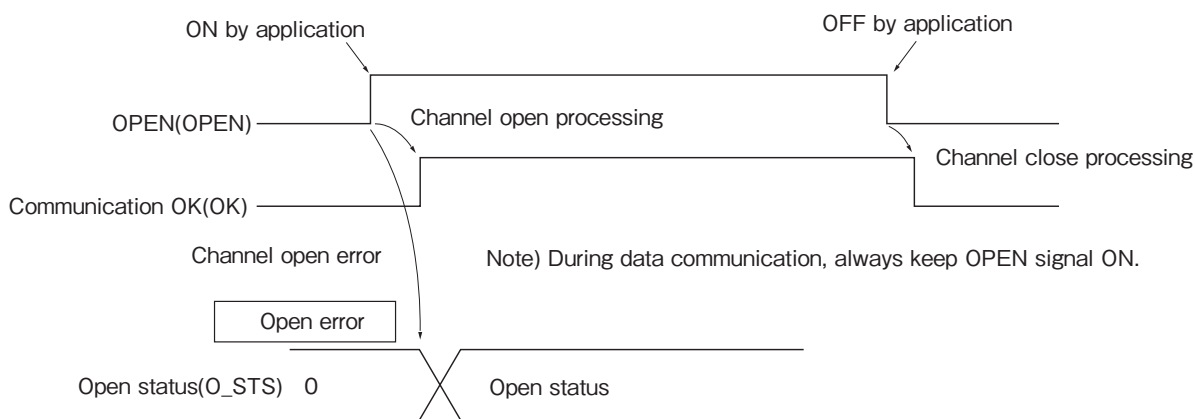
Array element number	Item	Data type	Description
0	Communication module number	UINT	Set SX bus station number of target Ethernet communication module. ET1: 1 to 238. CPU with built-in Ethernet: 247 to 254 (SX bus station number of CPU module).
1	Master-side port number	UINT	Specify port number of MODBUS master device. The actual port number of the master device may optionally be specified in the range of 1 to 65535. However, specify "1" if not particularly specified by the communicating device or a port number (1 to 65535) not used in the connected network environment.
2	Slave response monitor timer Note 1)	UINT	Set monitor timer value, in units of 0.1 seconds, from the time the master FB transmits a request message to the slave until it receives a response message from the slave.
3	Ethernet communication module type	UINT	Set type of Ethernet communication module to handle MODBUS Ethernet communication. (0: ET1, 1: CPU's built-in Ethernet)
4 ~ 9	Reserve	UINT	Not used.

Note 1) Set the same value as the "TCP transmission timeout value" specified in module parameters.

2 – 2 – 2 Communication procedures

(1) Channel open procedures

Turn the FB's OPEN terminal ON to open Ethernet TCP/IP channel. If the channel is opened normally, "communication OK" turns ON. If it is not opened due to errors in communication parameter settings or hardware problems, the FB outputs an error code to the open status (O_STS).

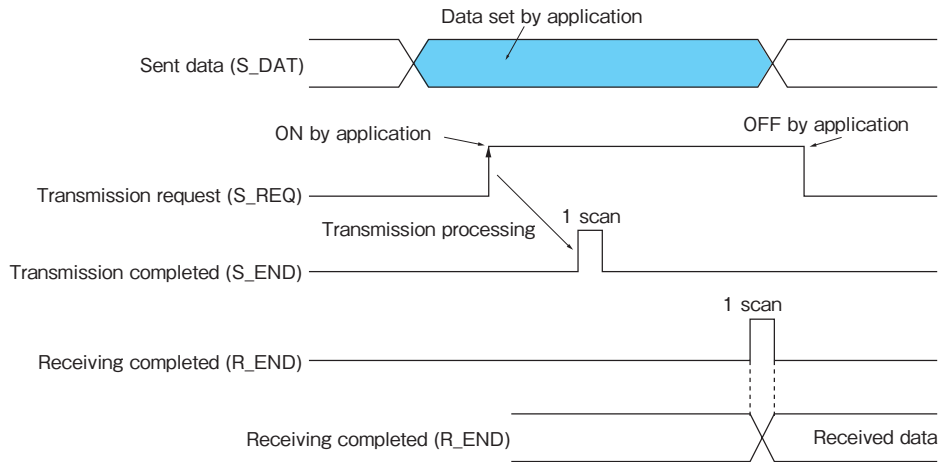


< Open status >

Open status	Processing result	Cause
00	Completed normally	—
10	Error in specified Ethernet communication module station	In the case of NP1L-ET1: A station number other than 1 to 238 was set. In the case of CPU with built-in Ethernet: A station number other than 247 to 254 was set.
11	Error in specified master-side port number	A number other than 1 to 127 was set.
12	Error in specified slave response monitor timer	A value smaller than 0 was set.
13	Error in specified Ethernet communication module type	A value other than 0 and 1 was set.
14	Error in communication parameter change	The following parameter was changed after the channel was opened: - Ethernet communication module station number - Master-side port number
91	Open failed	No response, channel open error, etc.

(2) Data communication procedures

In MODBUS protocol, there are definitions of master station and slave station. The master station (MICREX-SX is the master) always starts communication and the slave station responds to it. The transmission procedure is outlined below:



- ① Set data to be sent and turn ON transmission request by application. The FB detects rising and executes transmission.
- ② When transmission is completed normally, S_END turns ON during 1 scan and waits for response data from the slave device.
When transmission ends abnormally, S_ERR turns ON during 1 scan, and an error code is output to the transmission status (S_STS).
- ③ When response data from the slave station is received normally, R_END turns ON during 1 scan, and received data are output to R_DAT and output terminal (ADD_O, for example). When a receiving error occurs, R_END and R_ERR turn ON during 1 scan, and an error code is output to the receive status.

< Transmission status >

Code(h)	Processing result	Cause
00	Completed normally	—
10	Unsupported function	An unsupported function code was set.
11	Error in specified slave station number	A number other than 1 to 255 was set.
12	Error in specified data length	The setting range varies depending on function code: - Function code 01/02(h): 1 to 2000 points - Function code 03/04(h): 1 to 125 words - Function code 0F(h): 1 to 1968 points - Function code 10(h): 1 to 123 words
13	Error in specified number of bytes	The setting range varies depending on function code: - Function code 0F/10(h): 1 to 246 bytes
91	Transmission failed	Message transmission error (no response received from the other device, for example)

< Receive status >

Code(h)	Processing result	Cause
00	Completed normally	—
20	Renew ID mismatch	The requested renewal ID and the responding renewal ID do not match.
21	Function code mismatch	The requested function code and the responding function code do not match.
22	Slave station (unit ID) mismatch	The requested station number and the responding station number do not match.
23	Abnormal response	Data larger than the receive buffer was received.
24	Receiving timeout	No response was received from the slave within the time set in the communication parameter.
91	Receiving failed	Error in receiving message (the communication port of the other device is not open, for example).

2 – 2 – 3 RAS information

The RAS information area is used to check the operation status of the FB.
When using RAS information in application, variables are declared as follows:

< Variable declaration example >

VAR RAS : _C_RAS_TYPE11EMDM; END_VAR	RAS.RAS[0]	The number of transmission requests
	RAS.RAS[1]	The number of times transmission normally ends
	RAS.RAS[2]	The number of times receiving normally ends
	RAS.RAS[3]	M_OPEN status
	RAS.RAS[4]	M_SEND status
	RAS.RAS[5]	M_RECEIVE status
	RAS.RAS[6]	The number of open errors
	RAS.RAS[7]	The number of transmission errors
	RAS.RAS[8]	The number of receiving errors
	RAS.RAS[9]	The number of times no slave response is received (for the master only)

- ① Number of transmission requests: Counts rise of S_REQ input terminal.
- ② Number of times transmission normally ends: Counts rise of M_SEND DONE output terminal.
- ③ Number of times receiving normally ends: Counts rise of M_RECEIVE NDR output terminal.
- ④ M_OPEN status: Stores M_OPEN FB STATUS output terminal information.
- ⑤ M_SEND status: Stores M_SEND FB STATUS output terminal information.
- ⑥ M_RECEIVE status: Stores M_RECEIVE FB STATUS output terminal information.
- ⑦ Number of open errors: When OPEN request is received, counts rise of M_OPEN FB ERROR output terminal or errors in specified communication parameters.
- ⑧ Number of transmission errors: Counts rise of M_SEND FB ERROR output terminal or errors in specified transmission data.
- ⑨ Number of receiving errors: Counts rise of M_RECEIVE FB ERROR output terminal or errors in receiving data.
- ⑩ Number of times no slave response is received: Counts slave response monitor timer timeout.

Chapter 2 Specifications

2 – 3 MODBUS Ethernet slave FB _C_emods

2 – 3 – 1 _C_emods specifications

_C_emods is an FB for MICREX-SX, as a slave, to establish data communication with MODBUS master device.

※For transmission parameters for MODBUS devices, refer to the manual of each device.

(1) Function codes

This FB supports the following functions. For data format for each function, refer to “(4) Message format.”

Function code	Function
01	Read coil (output)
02	Read input
03	Read holding register
04	Read input register
05	Force ON/OFF (1 bit)
06	Write holding register (1 word)
0F	Force ON/OFF (multiple bits)
10	Write holding registers (multiple words)

(2) FB memory size

Program area = 1431 steps

Data memory size = Instance memory for user FB :130 words

Standard memory :568 words

Retain memory :10 words

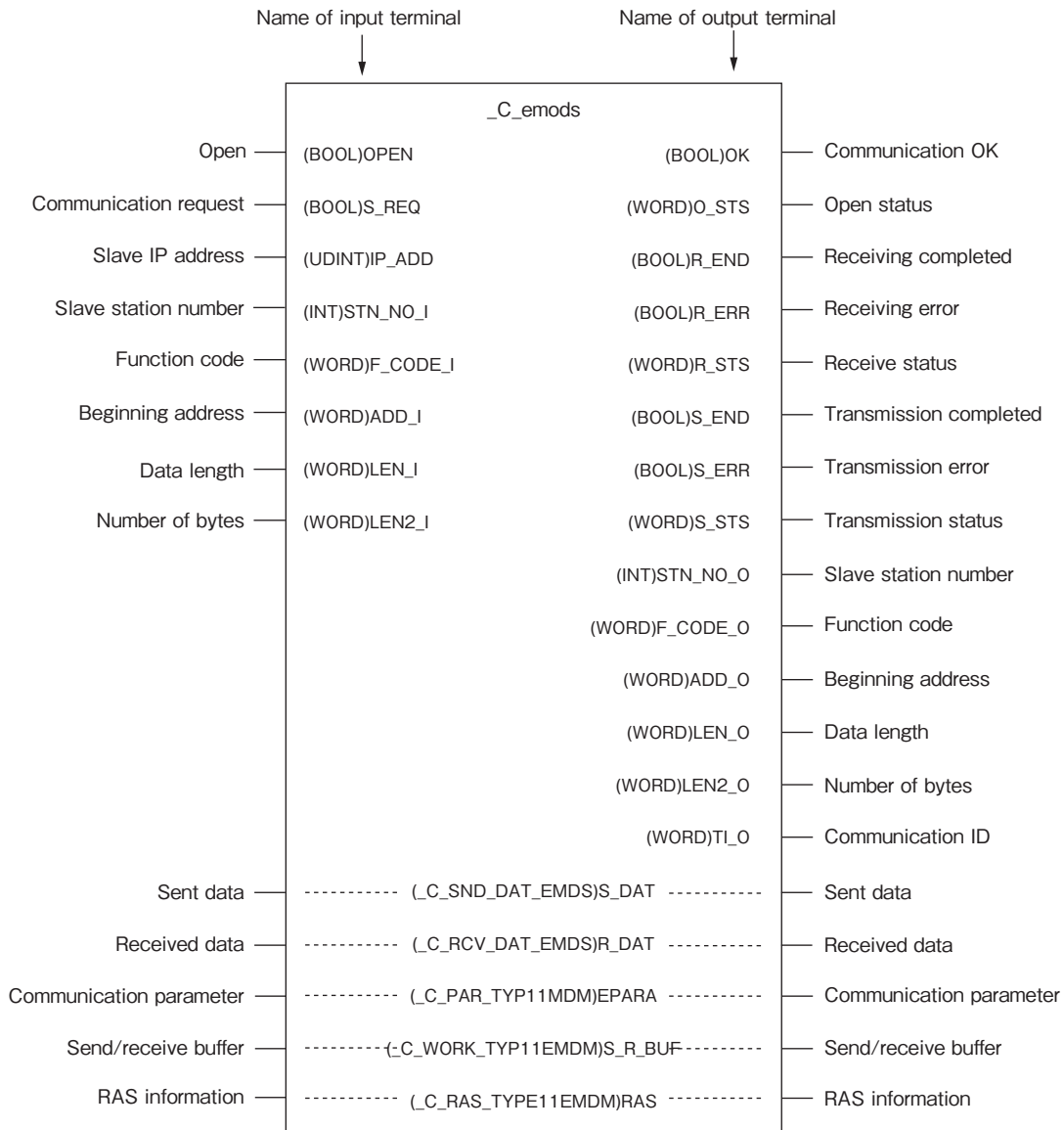
Instance memory for system FB :50 words

Note1) The above memory size includes the sizes of MODBUS FB itself and sub-FB accessed by MODBUS FB.

Note 2) The above “standard memory” or “retain memory” size includes the memory required to transmit/receive data.

Chapter 2 Specifications

(3) FB form



Chapter 2 Specifications

(4) Description of each FB terminal

Terminal name	Variable name	Data type	Input/output	Description
Open	OPEN	BOOL	IN	ON:Opens channel with MODBUS master device. When communication becomes available, "communication OK" turns ON. OFF: Ends communication. "Communication OK" turns OFF.
Transmission request	S_REQ	BOOL	IN	Starts sending data. It must be turned OFF by application when transmission is ended.
Master IP address	IP_ADD	UDINT	IN	Specify the IP address of transmission destination master station number. Example) In the case of 192.168.0.1, specify UIDNT#16#C0A80001.
Slave station number (Query)	SIN_NO_I	INT	IN	Not used for this FB. Set INT#0.
Function code (Query)	F_CODE_I	WORD	IN	Specify MODBUS function to be used. Set the code to low byte. Example) In the case of function (01h) – read coil, WORD#16#0010.
Beginning address (Query)	ADD_I	WORD	IN	Specify the beginning address of data to be read or written. Set data in the following format: 15 Low 8 7 High 0
Data length (Query)	LEN_I	WORD	IN	Specify the size (number of bits or words) of data to be read or written. This may not be used depending on the function used. In that case, set "0000h." Set data in the following format: 15 Low 8 7 High 0
Number of bytes (Query)	LEN2_I	WORD	IN	Specify the number of data bytes to be written when writing multiple bits (0F) or multiple words (10). In the case of other functions, set "WORD#16#0000." Set data in the following format: 15 Low 8 7 High 0
Sent data	S_DAT	_C_SND _DAT_EMDS	IN_OUT	Stores sent data. In the case of data readout and diagnosis, set all data to 0.
Received data	R_DAT	_C_RCV _DAT_EMDS	IN_OUT	Stores received data.
Communication parameter	PARA	_C_PAR _TYP11MDS	IN_OUT	Stores parameter for initialization. For details, refer to 2-3-1 (6).
Send/receive buffer	S_R_BUF	_C_WORK_ TYP11EMDS	IN_OUT	Memory internally used by this FB. Do not access this in applications.
RAS information	RAS	_C_work _TYPE11MS	IN_OUT	Stores operation status of this FB.
Communication OK	OK	BOOL	OUT	Turns ON when channel opening with MODBUS master device is completed normally.
Open status	O_STS	WORD	OUT	2-digit hexadecimal code to indicate open result.
Receiving completed	R_END	BOOL	OUT	Turns ON when data receiving from MODBUS master device is completed normally.
Receiving error	R_ERR	BOOL	OUT	Turns ON when an error occurs while receiving data from MODBUS master device.
Receive status	R_STS	WORD	OUT	Code to indicate receiving result.

Terminal name	Variable name	Data type	Input/output	Description
Transmission completed	S_END	BOOL	OUT	Turns ON when data transmission to MODBUS slave device is completed normally.
Transmission error	S_ERR	BOOL	OUT	Turns ON when data transmission to MODBUS slave device ends abnormally.
Transmission status	S_STS	BOOL	OUT	Code to indicate transmission result.
Master station number (Response)	STN_NO_O	INT	OUT	Outputs the number of the responding master station.
Function code (Response)	F_CODE_O	WORD	OUT	In response to the request from this FB, values of "function code," "beginning address," "data length," and "number of bytes" in the response data from the master device are output. They are output in the same formats as those set for input (Query).
Beginning address (Response)	ADD_O	WORD	OUT	
Data length (Response)	LEN_O	WORD	OUT	
Number of bytes (Response)	LEN2_O	WORD	OUT	
Communication ID (Response)	TI_O	WORD	OUT	

< Definition of array >

The array data in this FB are defined as follows:

TYPE

```

_C_PAR_TYP11EMDS      : ARRAY[0..9]  OF UINT  ; (*parameter area*)
_C_SND_TYP11EMDS      : ARRAY[0..131] OF WORD  ; (*send buffer area*)
_C_RCV_TYP11EMDS      : ARRAY[0..131] OF WORD  ; (*receive buffer area*)
_C_SND_DAT_EMDS       : ARRAY[0..125] OF WORD  ; (*sent data area*)
_C_RCV_DAT_EMDS       : ARRAY[0..125] OF WORD  ; (*received data area*)
_C_WORK_TYPE11EMDS    :
STRUCT
    SND_BUF           : _C_SND_TYP11EMDS;      (*send buffer*)
    RCV_BUF           : _C_RCV_TYP11EMDS;      (*receive buffer*)
END_STRUCT
_C_RAS_TYP11EMDS      : ARRAY[0..9]  OF INT;    (*RAS area*)
END_TYPE

```

< Format of variable connected to sent data terminal S_DAT >

Arrange array variables to be connected to S_DAT, as follows:

< Assuming that the variable name is S_DAT >

```

VAR
    S_DAT : _C_SND_DAT_EMDS;
END_VAR

```

	High	Low
S_DAT[0]	Data2	Data1
S_DAT[1]	Data4	Data3
.	.	.
.	.	.
.	.	.
S_DAT[124]	Data250	Data249
S_DAT[124]	Reserve	Reserve

< Format of variable connected to received data terminal R_DAT >

Data to be connected to R_DAT are arranged as follows:

< Assuming that the variable name is R_DAT >

```

VAR
    R_DAT : _C_RCV_DAT_EMDS;
END_VAR

```

	High	Low
R_DAT[0]	Data2	Data1
R_DAT[1]	Data4	Data3
.	.	.
.	.	.
.	.	.
R_DAT[124]	Data250	Data249
R_DAT[125]	Reserve	Reserve

Note) Reserve is internally used by this FB.
Do not attempt to access it.

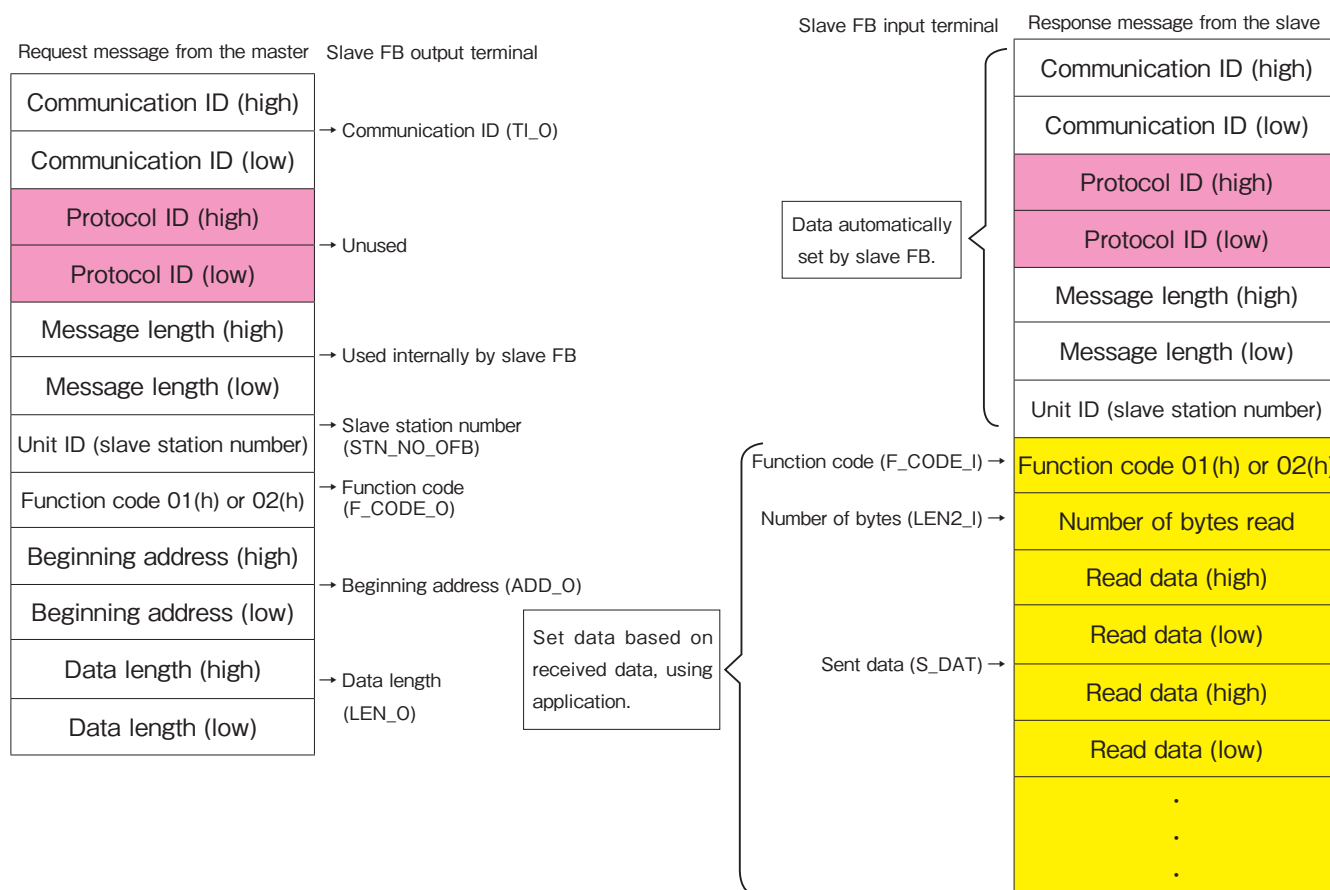
(5) Message format by function code

Information is output to this FB' s output terminal in response to request messages from the master device. Using the application, prepare necessary data and set it to this FB' s input terminal and input/output terminal.

① Read coil (code: 01(h)) / Read input bit (code: 02(h))

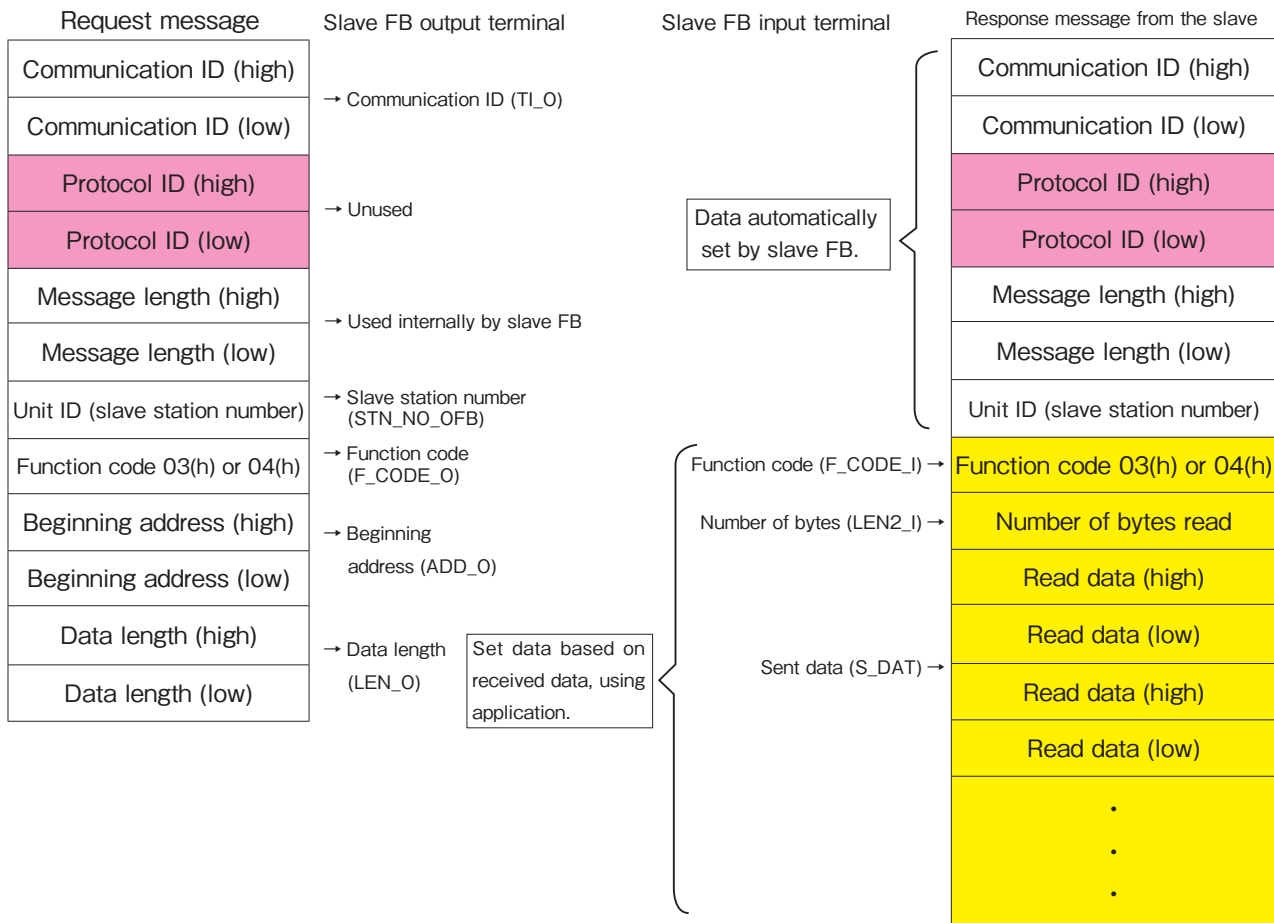
Formats of request messages from the master device and response messages are as follows.

Based on request messages output to the slave FB output terminal, set data to the slave FB input terminal using the application.



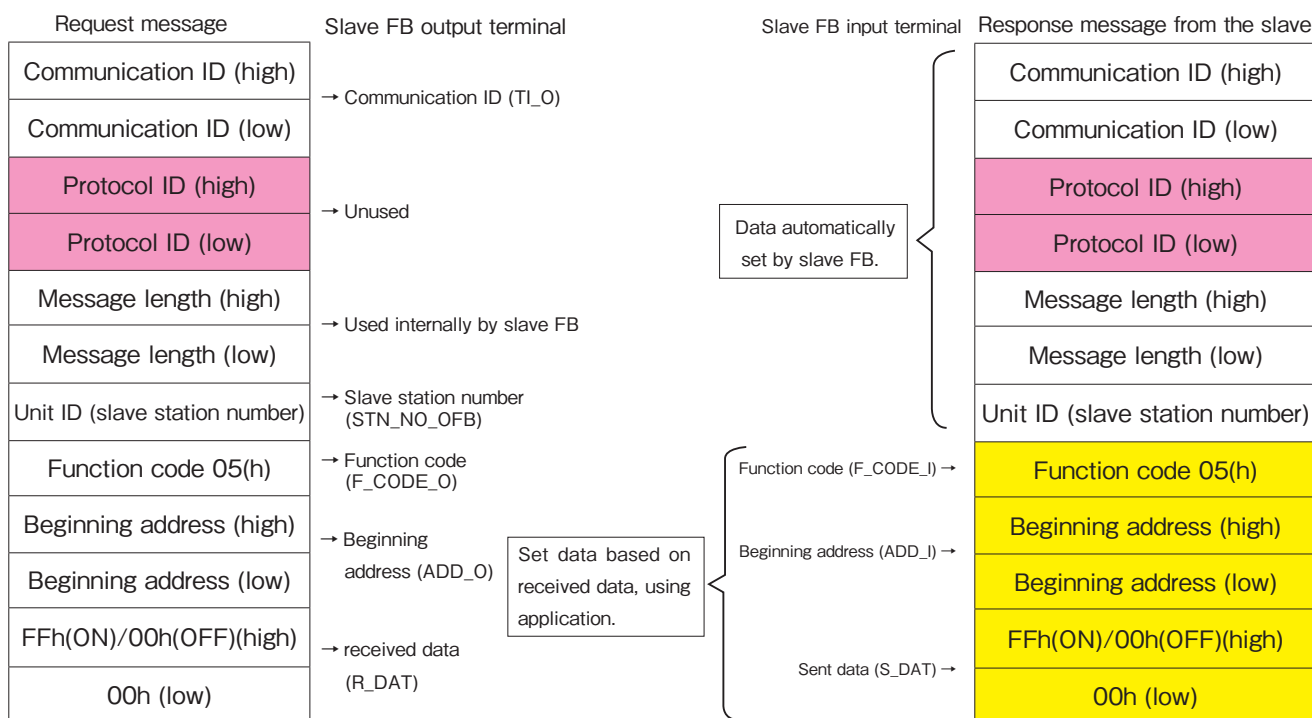
- ※ 1 For data length (LEN_O), the number of bit points read (1 to 2000 points) from the master station is output.
- ※ 2 The number of bytes (LEN2_O) and received data (R_DAT) are not used in function 01/02. Therefore, "0" is output.
- ※ 3 For S_DAT, set data that corresponds to the number of read bytes requested by the master using the application. If the number of read data points is not multiples of 8, set excess bits to 0 (OFF).
- ※ 4 For the number of bytes (LEN2_I), specify the number of bytes (1 to 250 bytes) in sent data (S_DAT).
- ※ 5 Beginning address (ADD_I) and data length (LEN_I) are not used. Set them to "0."

② Read holding register (code: 03(h)) / Read input register (code: 04(h))



- ※ 1 For data length (LEN_I), the number of read register words (1 to 125 words) is output.
- ※ 2 The number of bytes (LEN2_O) and received data (R_DAT) are not used in function 01/02. Therefore, "0" is output.
- ※ 3 For S_DAT, specify data that corresponds to the number of read bytes requested by the master, using application.
- ※ 4 For the number of bytes (LEN2_I), specify the number of bytes (1 to 250 bytes) in sent data (S_DAT).
- ※ 5 Beginning address (ADD_I) and data length (LEN_I) are not used. Set them to "0."

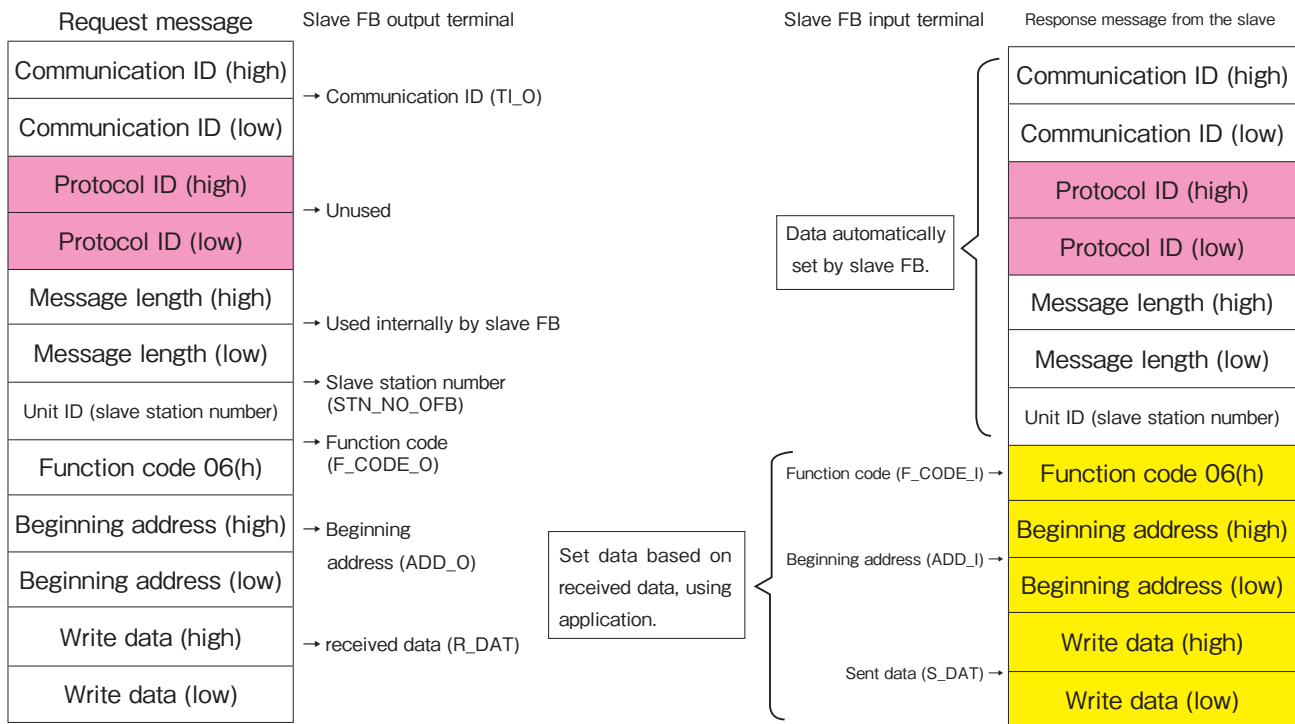
③ Force ON/OFF (1 bit) (code: 05(h))



- ※ 1 Output as the beginning word of received data (R_DAT) are WORD#16#FF00 if the master station request is force ON and WORD#16#0000 if it is force OFF.
- ※ 2 Data length (LEN_O) and number of bytes (LEN2_O) are not used in function 05(h). Therefore, "0" is output.
- ※ 3 After specified device ON/OFF processing is completed, set sent data (S_DAT) to WORD#16#FF00 in the case of force ON and WORD#16#0000 in the case of force OFF.
- ※ 4 Data length (LEN_I) and number of bytes (LEN2_I) are not used. Set them to "0."

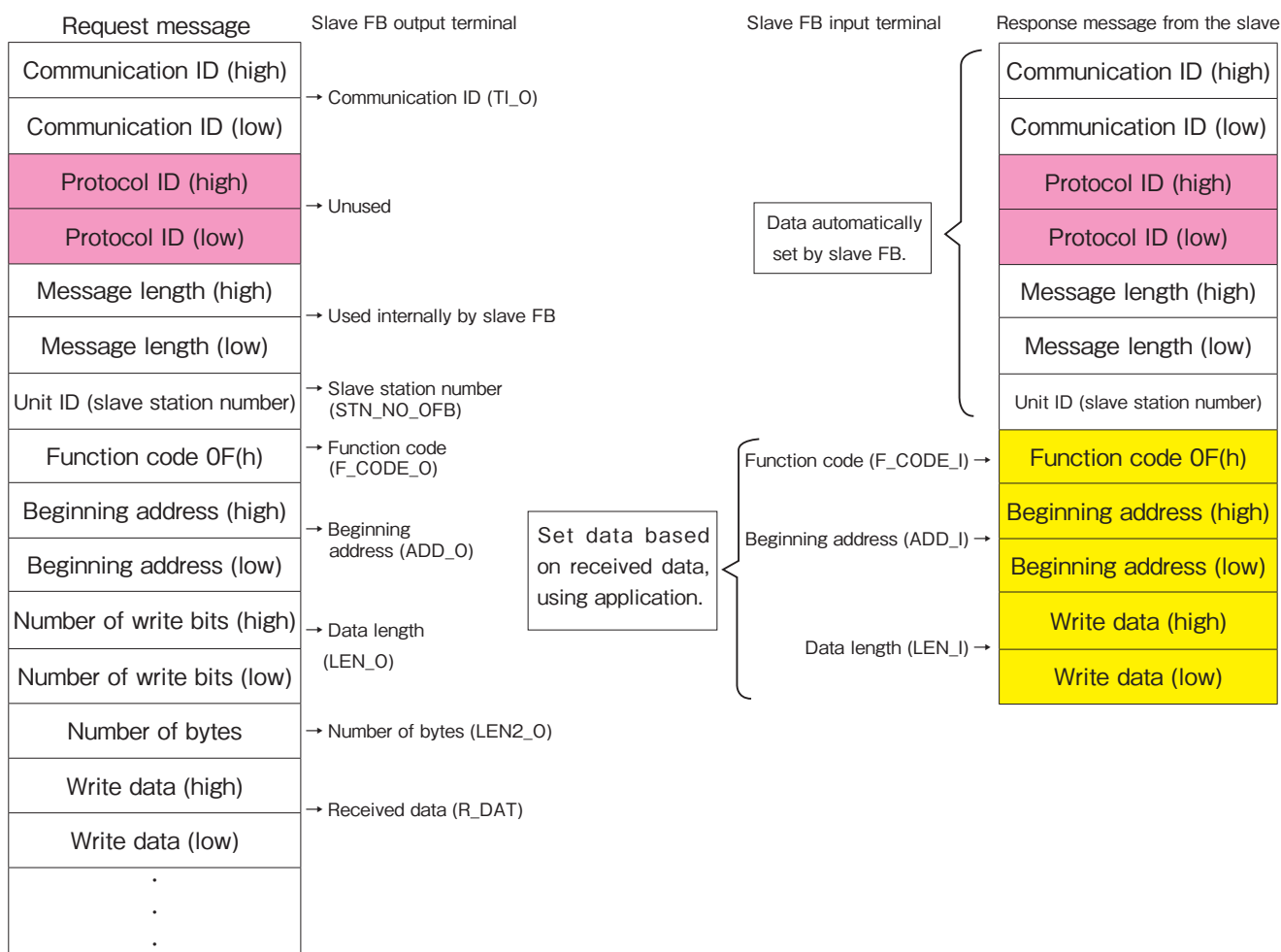
Chapter 2 Specifications

④ Write holding register (1 word) (code: 06(h))



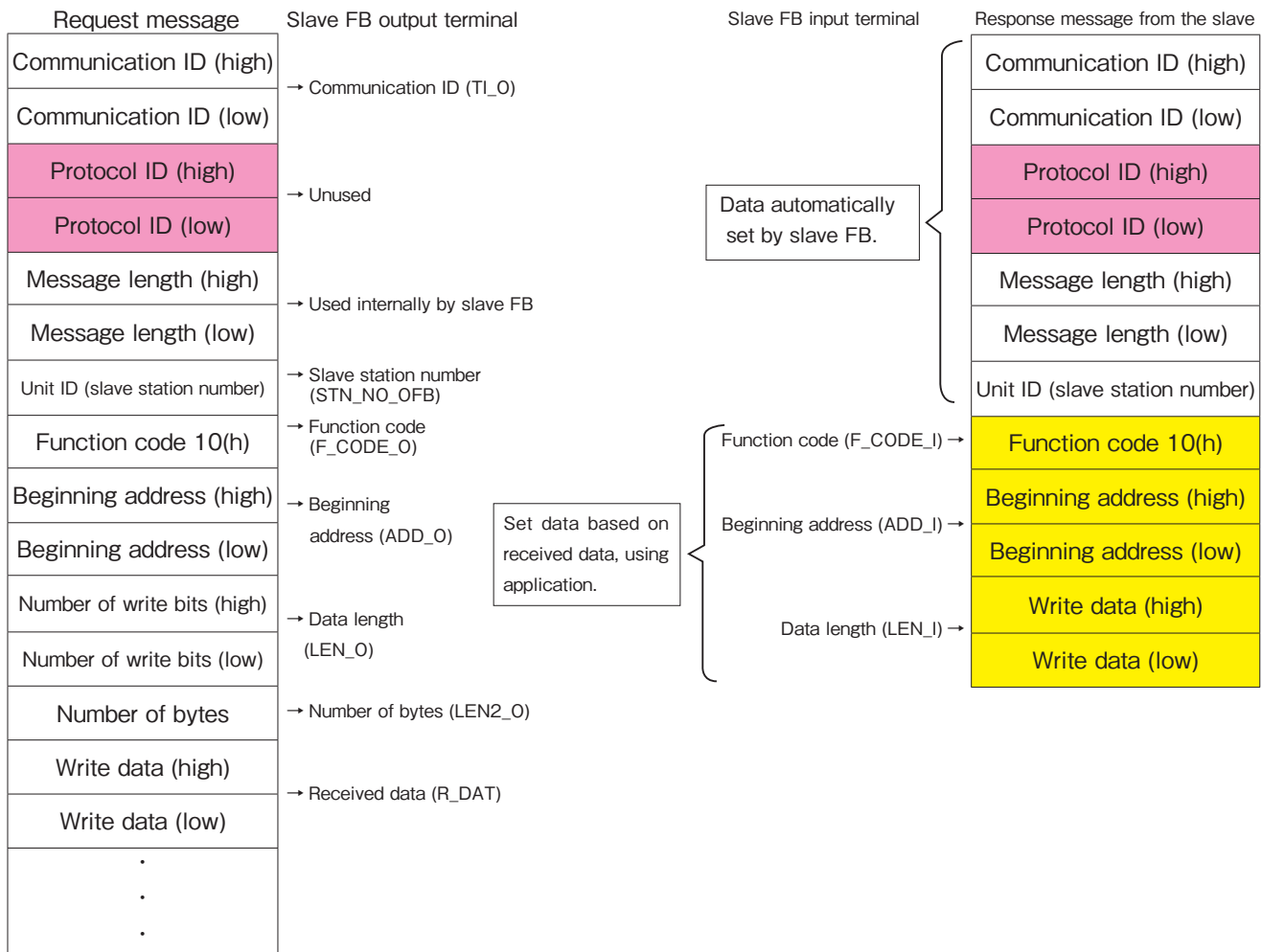
- ※ 1 Requested write data from the master station is output to received data (R_DAT).
- ※ 2 Data length (LEN_O) and number of bytes (LEN2_O) are not used in function 06(h).
Therefore, "0" is output.
- ※ 3 After write processing is completed, set write data from the master (R_DAT) in sent data (S_DAT).
- ※ 4 Data length (LEN_I) and number of bytes (LEN2_I) are not used. Set them to "0."

⑤ Force ON/OFF (multiple bits) (code: 0F(h))



- ※ 1 Output to data length (LEN_O) is the number of write bit points requested by the master station (1 to 1968 points).
- ※ 2 Output to the number of bytes (LEN2_O) is the number of write data bytes from the master station.
- ※ 3 Output to received data (R_DAT) is write data requested by the master station.
- ※ 4 After specified device ON/OFF processing is completed, set the number of write bit points requested (1 to 1968 points) in data length (LEN_I).
- ※ 5 Number of bytes (LEN2_I) and sent data (S_DAT) are not used. Therefore, set them to "0."

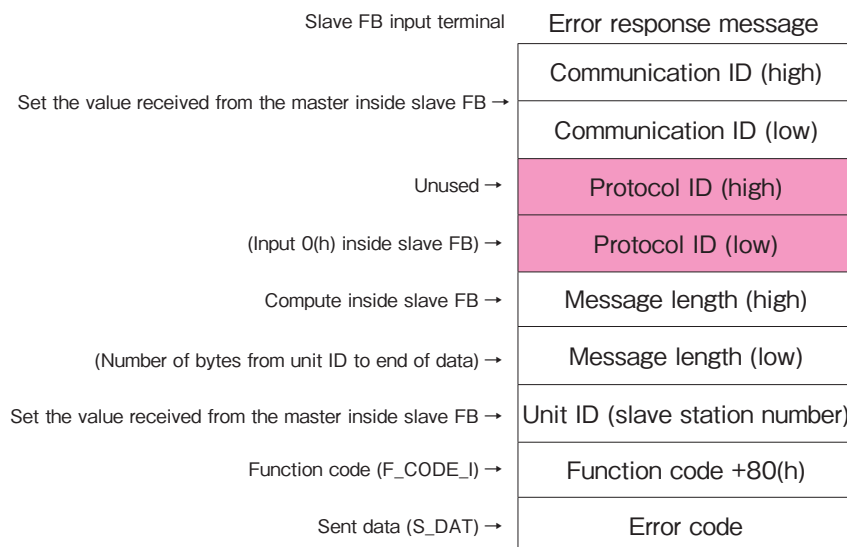
⑥ Write holding registers (multiple words) (code: 10(h))



- ※ 1 Output to data length (LEN_O) is the number of write words requested by the master station (1 to 123 words).
- ※ 2 Output to the number of bytes (LEN2_O) is the number of write data bytes from the master station (1 to 246 bytes).
- ※ 3 Output to received data (R_DAT) is write data requested by the master station.
- ※ 4 After specified device write processing is completed, set the number of write words requested (1 to 123 words) in data length (LEN_I).
- ※ 5 Number of bytes (LEN2_I) and sent data (S_DAT) are not used. Therefore, set them to "0."

⑦ Error response format

The error response format is as follows. This applies to all functions.



- ※ 1 In function code (F_CODE_O), set the value of the function code requested by the master plus 80(h).
 Example) If requested function code is 01(h), set 81(h) in F_CODE_I.

< List of error codes >

01h : Error in function code

02h : Error in specified address

03h : Error in specified number of read/write data

(6) Communication parameters

There are two types of MODBUS Ethernet communication parameters: parameters set in module and parameters set in this FB.

① Module parameters

The parameters shown in the table below are set in the D300win system definition.

Item	Description	Initial value	Basic setting
IP address	IP address	192.168.0.1	Optional
	Subnet mask	255.255.255.0	Optional
Gateway	Default gateway	None	None
Detail setting	TCP send/receive timeout value: 0 to 300 (in units of 0.1 seconds)	300	300 Note 1)
	Maximum TCP end timer value: 0 to 600 (in units of 0.1 seconds)	0 (1 second)	0 (1 second)
	Response monitor timer value: 0 to 300 (in units of 0.1 seconds)	300 (30 seconds)	300 (30 seconds)
	Server FTP command monitor timer value (loader command monitor timer value): 0 to 3000 (in units of 0.1 seconds)	3000 (300 seconds)	3000 (300 seconds)
	Client FTP data connection monitor timer value (in units of 0.1 second) Note 3)	30	30
	Ethernet communication trace	No tracing.	This setting is invalid.
	Transmission retry interval: 0 to 10 (in units of 1 second) Note 4)	0	This setting is invalid.
	Number of transmission retries: 0 to 30 times Note 4)	12 times	This setting is invalid.
	Closing when TCP transmission timeout occurs	No channel closing.	This setting is invalid.
	Closing when response receiving timeout occurs	No channel closing.	This setting is invalid.
	Own port reference number: 0 to 65280	256	500 Note 5)
	Communicating device's port reference number: 0 to 65280	256	Note 2)

Note 1) Set the same value as the "slave response monitor timer" specified for the communication parameter.

Note 2) For master-side actual port number, specify "1" if not specified by the communicating device or a port number (1 to 65535) not used in a connected network environment. Therefore, specify own port reference number according to the actual port number to be set.

Note 3) This item is set for NP1L-ET1 only. The Ethernet parameters of CPU with built-in Ethernet do not include this item.

Note 4) This item is set for the Ethernet of CPU with built-in Ethernet only. NP1L-ET1 does not include this item.

Note 5) The slave-side actual port number is fixed at "502" in the MODBUS Ethernet communication specifications. Since own port number inside this FB is fixed at "2," specify "500" for own port reference number.

②Communication parameter settings in FB

Items to be set in array variables (data type: Array of 10 _C_PAR_TYP11EMDM UINT types) are shown in the table below:

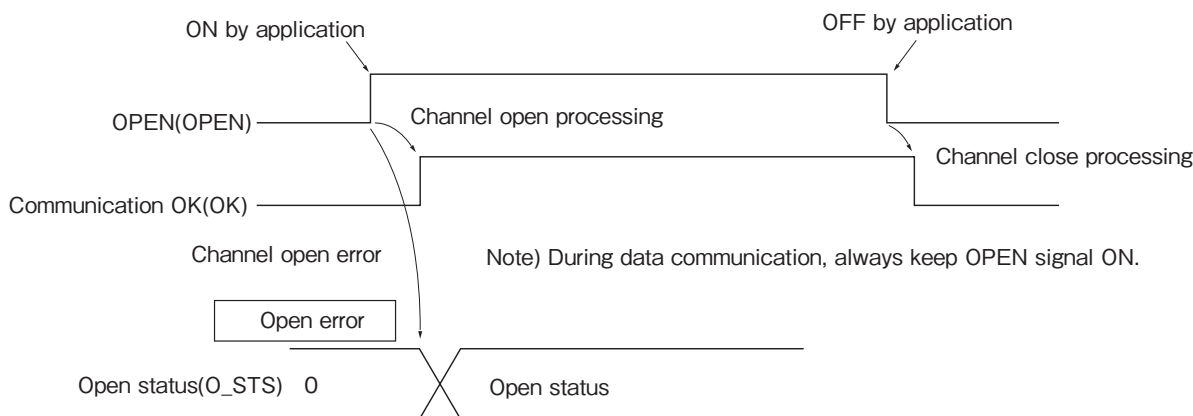
Array element number	Item	Data type	Description
0	Communication module number	UINT	Set SX bus station number of target Ethernet communication module. ET1: 1 to 238. CPU with built-in Ethernet: 247 to 254 (SX bus station number of CPU module).
1	Master-side port number	UINT	Specify port number of MODBUS master device. The actual port number of the master device may optionally be specified in the range of 1 to 65535. However, specify "1" if not particularly specified by the communicating device or a port number (1 to 65535) not used in the connected network environment.
2	Reserve	UINT	Not used
3	Ethernet communication module type	UINT	Set type of Ethernet communication module to handle MODBUS Ethernet communication. (0: ET1, 1: CPU' s built-in Ethernet)
4 ~ 9	Reserve	UINT	Not used.

Note 1) Set the same value as the "TCP transmission timeout value" specified for module parameters.

2 – 3 – 2 Communication procedures

(1) Channel open procedures

Turn the FB's OPEN terminal ON to open Ethernet TCP/IP channel. If the channel is opened normally, "communication OK" turns ON. If it is not opened due to errors in communication parameter settings or hardware problems, the FB outputs an error code to the open status (O_STS).



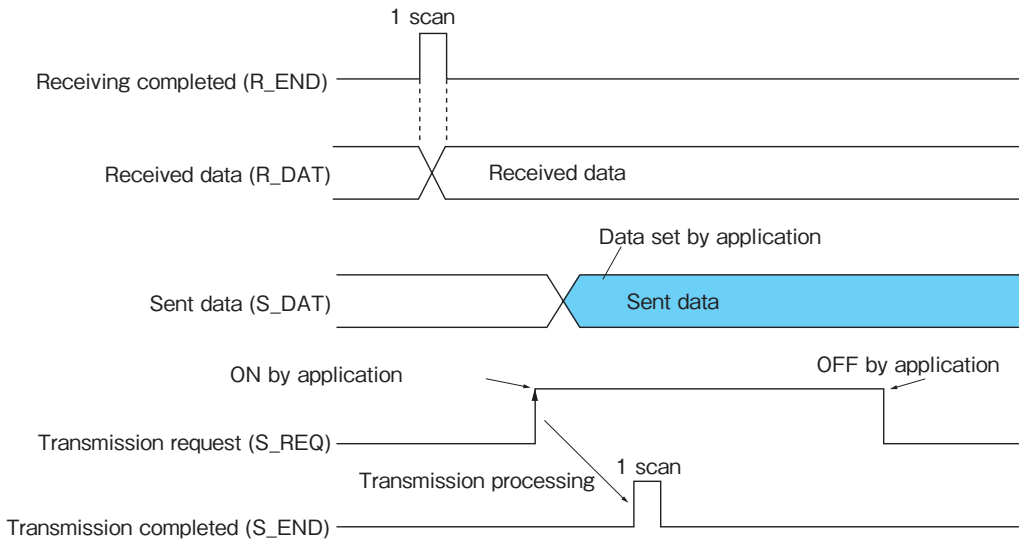
※ The communication OK terminal turns ON after connection with the communicating device is established. Therefore, in the slave FB, if connection with the master station is not established (open request is not made by the master) during the time set in "TCP send/receive timeout value in the module parameter settings," an open error occurs.

< Open status >

Code (h)	Processing result	Cause
00	Completed normally	—
10	Error in specified Ethernet communication module station	In the case of NP1L-ET1: A station number other than 1 to 238 was set. In the case of CPU with built-in Ethernet: A station number other than 247 to 254 was set.
11	Error in specified master-side port number	A number other than 1 to 127 was set.
13	Error in specified Ethernet communication module type	A value other than 0 and 1 was set.
14	Error in communication parameter change	The following parameter was changed after the channel was opened: - Ethernet communication module station number - Master-side port number
91	Open failed	No response, channel open error, etc.

(2) Data communication procedures

In MODBUS protocol, there are definitions for master station and slave station. The master station (MICREX-SX is the master) always starts communication and the slave station responds to it. The slave-side transmission procedures are outlined below:



- ① When request data from the master station is received, R_END turns ON during 1 scan. When a receiving error occurs, R_END and R_ERR turn ON during 1 scan, and an error code is output to the receive status.
- ② Analyze received data by application and execute requested processing. Then, set data to be sent and turn transmission request ON by application.
- ③ When transmission is completed normally; S_END turns ON during 1 scan and waits for the next request data from the master station. When transmission ends abnormally, S_ERR turns ON during 1 scan, and an error code is output to the transmission status.

< Transmission status >

Code (h)	Processing result	Cause
00	Completed normally	—
10	Unsupported function	An unsupported function code was set.
11	Error in specified slave station number	A number other than 1 to 255 was set.
12	Error in specified data length	- Function code 0F(h): 1 to 1968 points - Function code 10(h): 1 to 123 words
13	Error in specified number of bytes	- Function code 01 to 04(h): 1 to 250 bytes
91	Transmission failed	Message transmission error (no response received from the other device, for example)

< Receive status >

Code (h)	Processing result	Cause
00	Completed normally	—
10	Unsupported function	An unsupported function code was set.
11	Error in specified slave station number	A number other than 1 to 255 was set.
12	Error in specified data length	- Function code 01/02(h): 1 to 2000 points - Function code 03/04(h): 1 to 125 words - Function code 0F(h): 1 to 1968 points - Function code 10(h): 1 to 123 words
13	Error in specified number of bytes	- Function code 0F/10(h): 1 to 246 bytes
91	Receiving failed	Error in receiving message (the communication port of the other device is not open, for example).

2 – 3 – 3 RAS information

The RAS information area is used to check the operation status of the FB.

When using RAS information in application, variables are declared as follows:

< Variable declaration example >

```
VAR
  RAS : _C_RAS_TYPE11EMDS;
END_VAR
```

RAS.RAS[0]	The number of transmission requests
RAS.RAS[1]	The number of times transmission normally ends
RAS.RAS[2]	The number of times receiving normally ends
RAS.RAS[3]	M_OPEN status
RAS.RAS[4]	M_SEND status
RAS.RAS[5]	M_RECEIVE status
RAS.RAS[6]	The number of open errors
RAS.RAS[7]	The number of transmission errors
RAS.RAS[8]	The number of receiving errors
RAS.RAS[9]	Reserve

- ① Number of transmission requests: Counts rise of S_REQ input terminal.
- ② Number of times transmission normally ends: Counts rise of M_SEND DONE output terminal.
- ③ Number of times receiving normally ends: Counts rise of M_RECEIVE NDR output terminal.
- ④ M_OPEN status: Stores M_OPEN FB STATUS output terminal information.
- ⑤ M_SEND status: Stores M_SEND FB STATUS output terminal information.
- ⑥ M_RECEIVE status: Stores M_RECEIVE FB STATUS output terminal information.
- ⑦ Number of open errors: When OPEN request is received, counts rise of M_OPEN FB ERROR output terminal or errors in specified communication parameters.
- ⑧ Number of transmission errors: Counts rise of M_SEND FB ERROR output terminal or errors in specified transmission data.
- ⑨ Number of receiving errors: Counts rise of M_RECEIVE FB ERROR output terminal or errors in receiving data.

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Materials covered in this document are subject to revision due to the modification of the product.

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